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The long-run optimal degree of indexation in new Keynesian models with price staggering à la Calvo

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Abstract

This note shows that full price indexation is not optimal in the long-run, in the New Keynesian model under trend inflation and price staggering à la Calvo. Moreover, we show that more price stickiness may increase steady state welfare, if price indexation is partial.

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1 Introduction

Indexation of wages and prices was the subject of substantial literature in macroeconomics in the era of high inflation (see the seminal paper by Gray, 1976) and it has subsequently been neglected. Quite recently, however, many authors started to introduce various forms of indexation in the New Keynesian model, within the Calvo price staggering framework.

However, they do it in a completely *ad hoc* manner. First, the nowadays most popular form of indexation embedded in these models is the so-called backward-looking indexation. The main reason is empirical in order to have a lagged term in the New Keynesian Phillips Curve to match the inflation persistence in the data. Second, indexation is most of the times assumed to be full, which avoids the problems arising with positive inflation in steady state (see Ascari, 2004). In the empirical estimates of these models, however, indexation is usually found to be only partial.[1]

This note follows the spirit of Gray (1976) by treating indexation as a policy parameter. That is, we deal with the following question: given that we assume backward looking indexation (as most of the recent literature), is it optimal to set full indexation? We think that this approach may be helpful in understanding how indexation shape trade-offs in the model, influencing the normative conclusions one can obtain using the New Keynesian approach.

We decide to focus on the well-known Christiano et al., 2005 (CEE henceforth) medium-scale model, which is becoming a benchmark model for the literature, because it is theoretically quite rich and empirically successful. We will then ask which are the values of price and wages indexation that maximize welfare in the deterministic Ramsey steady state of the CEE model.

2 The Model

The main features of the model are: (i) *Households*: habit persistence in consumption, money in the utility function, each household comprises all the type of labors and owns capital stock, sticky wages a la Calvo; (ii) *Firms*: Cash-in-advance constraint on wage payments, monopolistic competition, price stickiness a la Calvo, standard Cobb-Douglas production function plus a fixed cost to guarantee zero profit in equilibrium, variable capacity utilization, adjustment costs in investment; (iii) Government expenditure is financed through lump-sum taxes and seigniorage. We use the same functional forms, notation and calibration of SGU (2004).

In this note we focus on indexation, which in the CEE model takes the popular form of backward-looking indexation. In other words, those prices (and wages) that can not change are automatically updated accordingly to the level of price (wage) inflation in the previous period.

[1] See, e.g., Christiano et al. (2005) for the U.S., Smets and Wouters (2003) and for the Euro area.

For a detailed description of the model see for example Schmitt-Grohé Uribe (2004) (SGU henceforth).

3 The Ramsey Steady State

Both CEE and SGU assume that wages and prices are fully indexed, that is indexation is 100%. In this note we ask the model what are the values of $\chi \in [0,1]$ (i.e., degree of price indexation) and of $\tilde{\chi} \in [0,1]$ (i.e., degree of wage indexation) that maximize the steady state welfare of the representative household.

Following the literature initiated by Gray (1976) we treat indexation as a policy parameter. Consider the problem of a benevolent planner that seeks to maximize the present value of the utility choosing the optimal level of inflation, price and wage indexation.

Schmitt-Grohé and Uribe (2007) has partially investigated this issue. In this same model they let vary the price-indexation parameter between 0 and 1 and look for the optimal Ramsey steady state inflation. Their main result is that the trade-off between the Friedman Rule and the inflation stability is resolved in favor of inflation stability, with a steady state level of inflation close to zero. When indexation increases toward 1, reducing the long-run effect associated with inflation, the optimal level of inflation moves toward the Friedman rule[2]. In light of their analysis we expect to find that a benevolent planner maximizing over inflation and the indexation parameters, would solve both inefficiencies setting indexation equal to 1 and the inflation rate equal to the discount rate, i.e. the Friedman Rule.

Surprisingly the solution of the Ramsey problem is:

$$\pi^*_{Ra} = \beta \quad \tilde{\chi}^*_{Ra} = 1 \quad \chi^*_{Ra} = 0.95$$

i.e. the Friedman rule, full wage indexation but partial price indexation. To investigate the trade-off behind the Ramsey solution we study the steady state in the next section.

4 Steady State Analysis

We expected to find full indexation (i.e., χ,$\tilde{\chi} = 1$) to be optimal in steady state[3]. The effect of indexation is visualized in Figure 1, that shows welfare as a function of χ and $\tilde{\chi}$ (prices and wages indexation respectively). This graph reveals that no indexation gives the worst outcome. Figure 2 instead uncovers our main result. While steady state welfare is ever increasing in the wage indexation parameter, $\tilde{\chi}$, for a given $\tilde{\chi}$, it is first increasing and then decreasing in the price indexation parameter. It follows that for any $\tilde{\chi}$, full price indexation is never optimal.

[2] See SGU (2007) for a further discussion on this topic.

[3] For the sake of simplicity , we analyze the case of positive trend inflation, calibrating the model to the US average inflation (4.2%) as SGU. Note however that the arguments provided are indipendent from the sign of inflation, given that it is different from 0.

Result 1 The maximum steady state welfare level is attained at full wage indexation, but partial price indexation, that is $\tilde{\chi} = 1$ and $\chi = 0.88$.

Corollary The value of $\chi = 0.88$ maximizes steady state welfare, for *any* level of $\tilde{\chi}$

The corollary of Result 1 suggests that the source of optimality of partial indexation is to be found in other inefficiencies rather than the nominal frictions in the model. In order to explain our intuition we follow the line of argument in King and Wolman (1996). King and Wolman (1996) focus their attention on the average mark-up in the economy. The average mark-up is a measure of the monopolistic distortion in the whole economy, i.e., a lower average mark-up should be associated with a higher welfare level. Moreover in all the New Keynesian models, monopolistic competition implies the existence of steady state inefficiencies.

The average mark-up can be expressed as

$$\frac{P_t}{MC_t} = \left(\frac{P_t}{\tilde{P}_t}\right)\left(\frac{\tilde{P}_t}{MC_t}\right) \tag{1}$$

where MC_t represents nominal marginal costs, P_t is the aggregate price level and $\tilde{P}_t$ is the optimal reset price.

The average mark-up is hence given by two factors: 1) the "price adjustment gap", defined as the ratio of the general price level to the price charged by resetting firms; 2) the "marginal mark-up", defined as the mark-up of the resetting firms.

In a steady state with full indexation, or with no long-run inflation, all prices and wages would be the same. So there would be no "price adjustment gap" and the average mark-up would equal the marginal mark-up, in turn simply given by the Lerner coefficient. Whenever there is partial price indexation this is no longer true, and the steady state exhibits price dispersion. In this environment P_t is lower than $\tilde{P}_t$ and a price adjustment gap emerges. Indeed with partial indexation, positive inflation mechanically erodes the relative price set by firms in past periods. This can be seen in the steady state version of the equation that defines the general price level[4]

$$\begin{aligned} P_t &= \left[\int_0^1 {P_{i,t}}^{1-\eta} di\right]^{\frac{1}{1-\eta}} = \left[\alpha \pi_{t-1}^{(1-\eta)\chi} P_{t-1}^{1-\eta} + (1-\alpha)\tilde{P}_t^{1-\eta}\right]^{\frac{1}{1-\eta}} \Longrightarrow ss \\ &\Longrightarrow \quad 1 = \left[\alpha \overline{\pi}^{(\eta-1)(1-\chi)} + (1-\alpha)\left(\frac{\tilde{P}}{P}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}} \\ &\Longrightarrow \quad \frac{P}{\tilde{P}} = \left(\frac{1-\alpha\overline{\pi}^{(\eta-1)(1-\chi)}}{1-\alpha}\right)^{\frac{1}{\eta-1}} \end{aligned} \tag{2}$$

[4] α is the probability of not being able to reset the price, $\overline{\pi}$ is the steady state gross inflation rate and η is the elasticity of demand for differentiated goods.

Note that, other things equal, *lower* price indexation decreases the price adjustment gap, since firms will try to shield themselves from the erosion of relative prices, thus decreasing the average mark-up in (1), and increasing welfare. Here it is therefore the positive effect of partial indexation: the lower χ, the lower the price adjustment gap and the lower the average mark-up in the economy.

The second effect instead concerns the marginal mark-up, which is also affected by partial indexation. Firms know that positive inflation erodes both their mark-up (since nominal marginal costs will increase with inflation) and their relative prices. This latter erosion would both increases their demand (which they have to satisfy by assumption) and decreases their per-unit profits. Thus, they react by resetting a higher price when they can, so that the lower the indexation parameter, the higher is the ratio $\frac{\tilde{P}_t}{MC_t}$. This is the negative effect of a lower indexation on the average mark-up in the economy: the lower χ, the higher the marginal mark-up and the higher the average mark-up in the economy.

These are hence the two conflicting forces acting in steady state. As displayed in Figure 3, for low levels of χ, the second effect dominates such that the average mark-up decreases with χ, and therefore welfare is increasing with indexation. However, at a certain point ($\chi = 0.88$), the two effects compensate and then the first effect prevails. For $\chi > 0.88$ the average mark-up increases, reducing welfare.

Following the same argument, the second effect instead always dominates with regard to wage indexation, given the CEE calibration.

To conclude, with positive trend inflation, partial price indexation can mitigate the monopolistic distortion in the steady state, thereby increasing welfare[5].

5 Price indexation and price stickiness

It would be interesting to look at the properties of the steady state defined by the optimal combination of the two indexation parameters, particularly exploring the comparative statics with respect to some parameters. The most obvious one to look at is the Calvo parameter of the price setting mechanism. The parameter α is the probability of not being able to reset the price, and it is set equal to to 0.6 in SGU 2004.

We expected welfare to be increasing with price flexibility, that is, for a given χ (and $\tilde{\chi}$), welfare would be decreasing with α. Indeed $\alpha = 0$ means complete price flexibility. This seems to be the case by looking at Figure 4 that plots welfare as α and χ vary. The lower welfare level is given the point $(\alpha, \chi) = (1, 0)$, as expected.

However, welfare is *increasing in* α, for certain values of χ. That is, in certain part of the surface in Figure 4, the higher price stickiness, the higher is welfare.

[5] Note that our arguments are not based on the particular form of indexation but rather on the presence of positive long-run inflation and monopolitic competition, so they are not affected by the assumption of indexation to past inflation.

Generally, this holds for quite high values of χ, as shown in Figure 5, and in particularly for $\chi = 0.88$.

Result 2 Given $\tilde{\chi} = 1$ and $\chi = 0.88$, steady state welfare is maximized for the maximum admissible level of price rigidity (i.e., $\alpha = 0.993$).[6]

Indeed, for *any value of* $\tilde{\chi}$ and for $\chi > 0.76$ welfare is increasing in α. The key variable is still the average mark-up in the economy, which is monotonically decreasing in price stickiness as shown in Figure 6. Marginal mark-up is increasing in α because price-setting firms increase their mark-up when the hazard rate of prices is lower. However the average mark-up decreases with α because the effect of the price adjustment dominates for high values of indexation. Therefore, we might conclude that price stickiness improves welfare by alleviating monopolistic distortions. Result 2 is surprising and should warn about the fact that a wrong calibration of indexation may mislead to the conclusion that nominal frictions are beneficial to the economy.

6 Conclusions

This note shows that full price indexation is not optimal in the long-run in the New Keynesian model, because of monopolistic distortion. The argument provided for the optimality of partial indexation is very different from the classical one in Gray (1976). Indeed, we are analyzing the steady state of a microfounded model, without considering any stochastic supply or demand shocks, that were instead crucial for Gray's (1976) argument. Moreover, we show that more price stickiness may increase steady state welfare, if price indexation is partial.

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[6] Given positive steady state inflation and partial indexation, there is a maximum value for α, such that the first order condition for reset price is defined (see Ascari, 2004).

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8 Figures

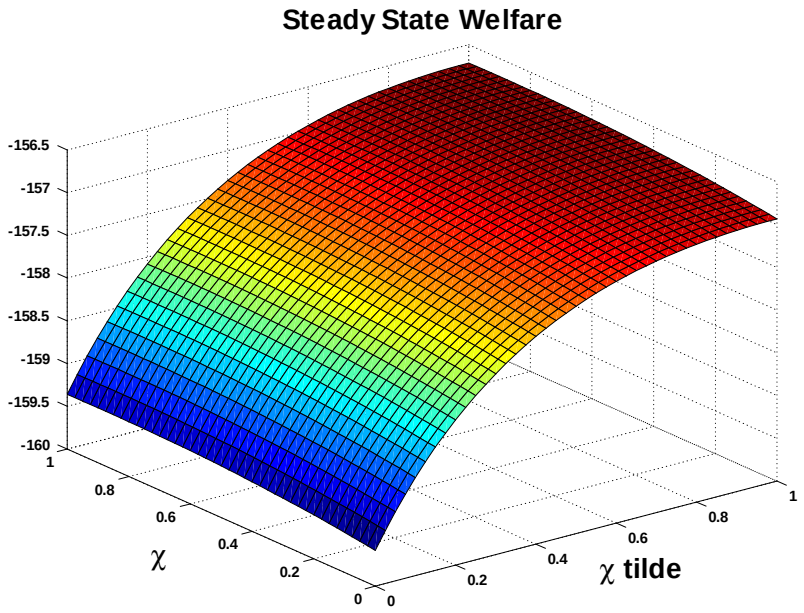


Figure 1

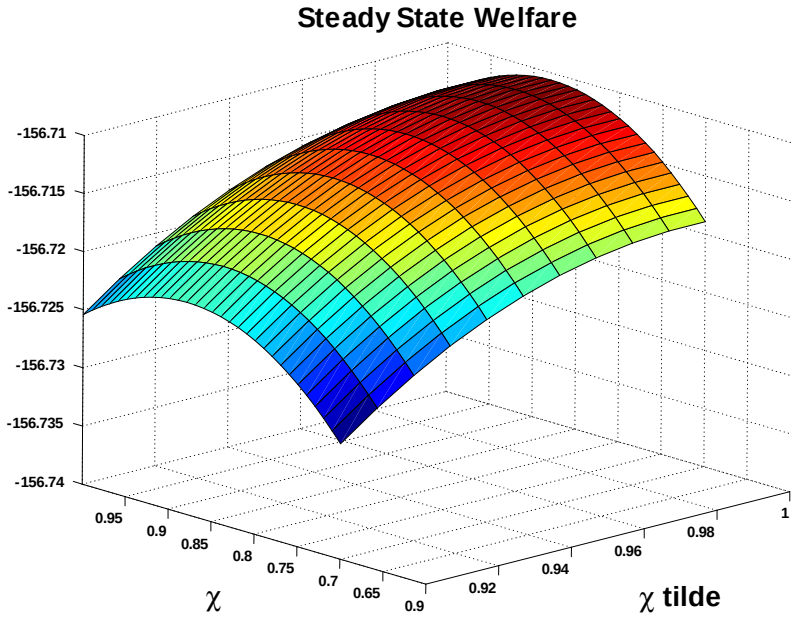


Figure 2

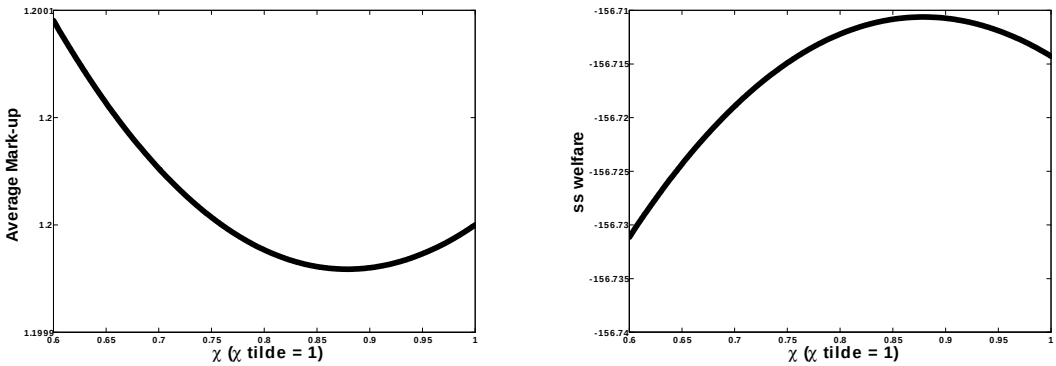


Figure 3

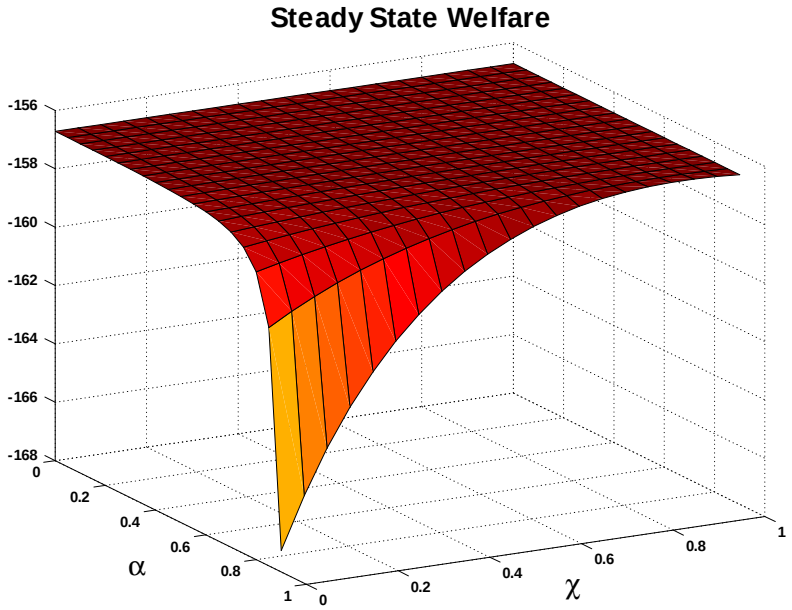

Steady State Welfare
-156
-158
-160
-162
-164
-166
-168
0
0.2
0.4
0.6
0.8
1
α
0
0.2
0.4
0.6
0.8
1
χ

Figure 4

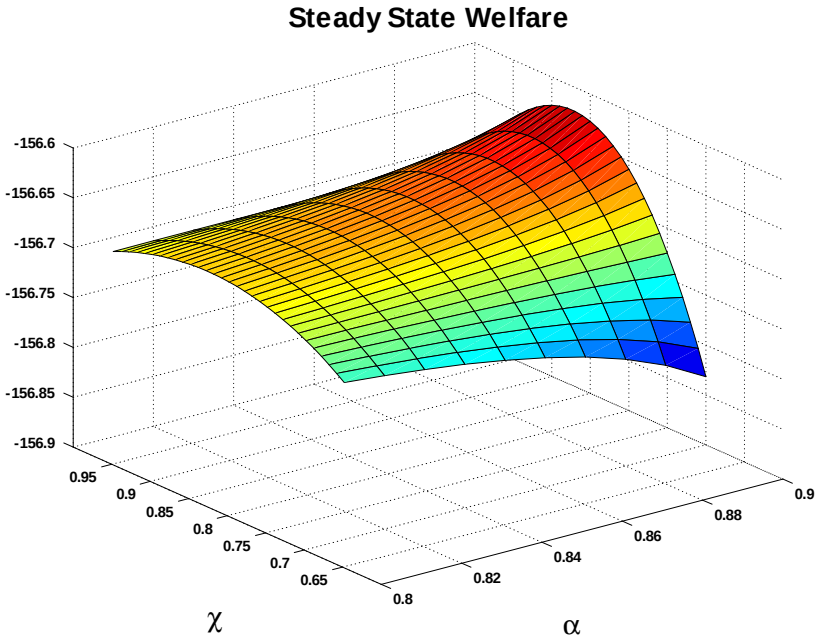
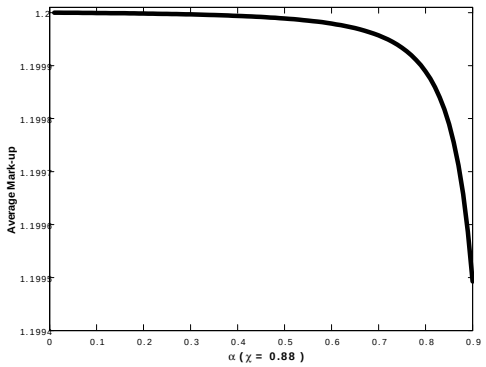

Steady State Welfare
-156.6
-156.65
-156.7
-156.75
-156.8
-156.85
-156.9
0.95
0.9
0.85
0.8
0.75
0.7
0.65
χ
0.8
0.82
0.84
0.86
0.88
0.9
α

Figure 5



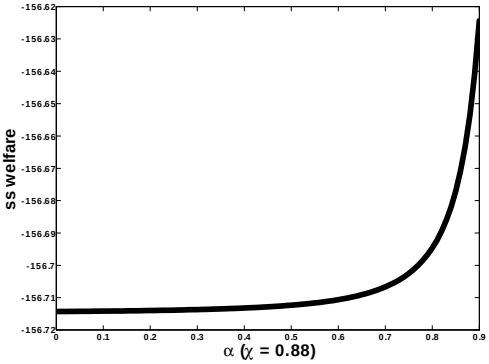


Figure 6